U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1328

PRODUCTION OF SEED FLAX

SEED FLAX is grown chiefly in North Dakota, Minnesota, South Dakota, and Montana. Since 1909 the production of flaxseed in the United States has not equaled the requirements of our industries. The crop of 1923, estimated at 17,429,000 bushels, was less than half the quantity consumed during the fiscal year.

Until recent years seed flax has always been grown on new lands, near the frontier. With the development of wilt-resistant varieties it is now grown successfully on the older cultivated lands.

On new land in the northern Great Plains varieties of European seed flax, such as North Dakota No. 155 and North Dakota Resistant No. 52, are best adapted. Where flax wilt is present a wilt-resistant variety, such as North Dakota Resistant No. 114, should be grown. Two new varieties, Chippewa and Winona, recently distributed by the Minnesota Agricultural Experiment Station, are well adapted to growing on wilt-infested soil.

Grow flax on clean land. Flax does well following corn which has been given clean cultivation. A rotation which includes a legume crop, such as field peas, soybeans, sweet clover, or red clover, followed by corn and finally by flax, is very satisfactory.

Flax and spring wheat are grown successfully as a mixed crop in southeastern Minnesota. The advantages of the mixed crop are (1) greater ease in handling, (2) better control of weeds, and (3) a possible greater return per acre. The mixed crop provides greater crop diversification where it can be grown successfully.

Flax should be sown early as a general rule on a well-prepared, firm seed bed. It may be sown as late as the first week of June, however, provided the land has been kept free from weeds by cultivation.

The rate of seeding ranges from about 20 pounds per acre on the drier lands of the northern Great Plains to 40 pounds per acre under the humid conditions of eastern Minnesota.

Flax is harvested with a grain binder, reaper, or header. It should be threshed as soon as it is thoroughly dry.

This bulletin supersedes Farmers' Bulletin 785, Seed-Flax Production.

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PRODUCTION OF SEED FLAX

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INTRODUCTION

THE UNFAVORABLE WHEAT SITUATION has again focused attention on flax as a cash crop. The good yields of flax obtained in 1922 and 1923, together with the satisfactory price received by producers, has made flax more profitable generally than wheat or oats. The increased acreage of flax in 1923, moreover, has provided greater diversification of crops in the area producing seed flax.

Flaxseed is the source of linseed oil. No satisfactory substitute has yet been found for linseed oil in the manufacture of paints and varnishes. The demand for flaxseed, therefore, during the building boom of recent years has been greater than ever before. This demand is likely to continue. There are thousands of farm buildings that are in need of paint and that no doubt will be painted when greater prosperity returns to the farming industry.

It is estimated by the paint industry that approximately 80 per cent of the paint and varnish consumed is used in repainting older buildings and only about 20 per cent on new buildings and manufactured goods, including machinery and automobiles.

HISTORY

Flax, grown for fiber, was one of the first crops introduced from the Old World. In colonial times nearly every household had its patch of flax, and it continued to be grown to some extent for home use as late as 1840. It was very early in the nineteenth century that the manufacture of linseed oil was begun in this country.

Until recent years flax has been a pioneer crop in the history of American agriculture, and the center of production has always been

near the frontier. The census of 1850 showed Ohio and Kentucky to be the leading flaxseed-producing States. By 1900 the center of production had shifted to North Dakota. During those 50 years the crop had migrated with the advance of settlement from Ohio across Indiana, Illinois, Iowa, and Minnesota to North Dakota. The crop evidently now has reached the western limit of its migra-

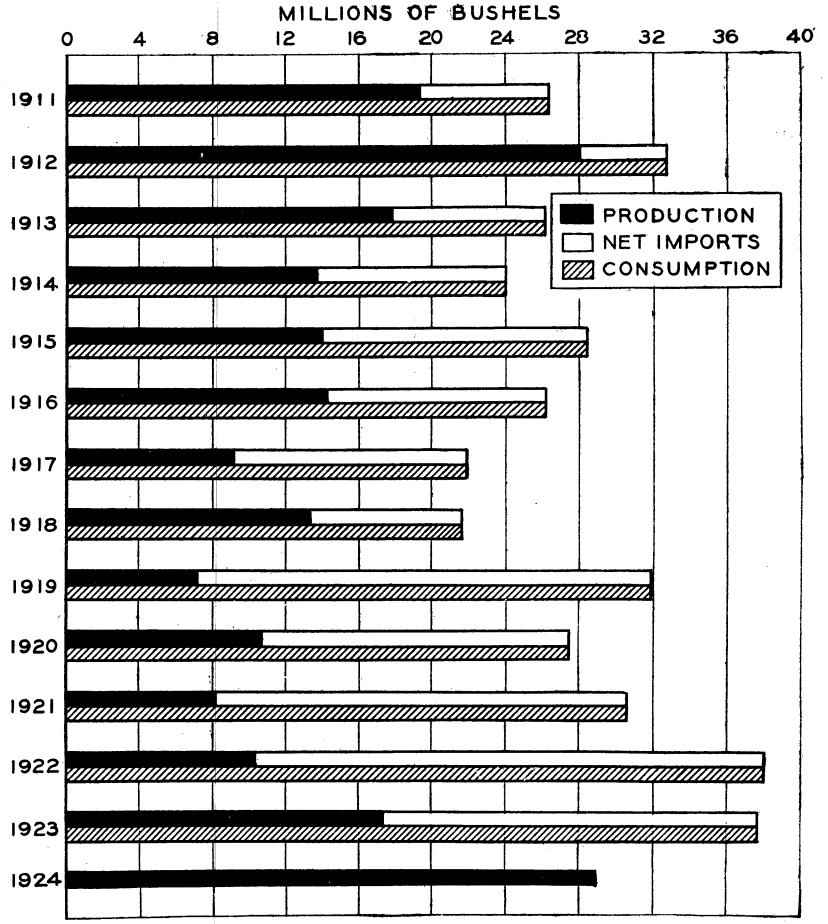

FIG. 1.—Flaxseed production, net imports (including linseed oil in terms of seed), and consumption in the United States from 1911 to 1923, inclusive, with a preliminary estimate of production in 1924. The chart is based on the revised production figures published in the Yearbook of the Department of Agriculture for 1923 and on preliminary estimates for 1923 and 1924 of the Division of Crop and Livestock Estimates. (Estimated production for the calendar years specified. Estimates of net imports and consumption for the commercial years beginning July 1 of the years specified)

tion. For the past 20 years North Dakota, Minnesota, and South Dakota have been the chief States in the production of flaxseed.

For 10 years previous to 1908 the United States produced a surplus of flaxseed, and considerable quantities were exported to Europe. Since 1908, however, the production of flaxseed has not been sufficient to meet the requirements of our industries, and in recent years large quantities have been imported from Argentina

and Canada. The consumption, production, and net imports of flaxseed in the United States from 1911 to 1923 are shown graphically in Figure 1.

THE FLAX-GROWING AREA

Flax is grown under a wide range of soil and climatic conditions. It produces best, however, on the clay-loam soils of the North-Central States where the summer temperature is moderate and rainfall adequate. The area of flaxseed production in 1919 is shown in Figure 2. In western Minnesota, eastern North Dakota, and northeastern South Dakota, the center of the flax-producing area, the average annual rainfall varies from 20 to 30 inches. In central North Dakota and South Dakota the rainfall averages 16 or 18 inches annually and diminishes westward to about 14 inches in central Montana. In

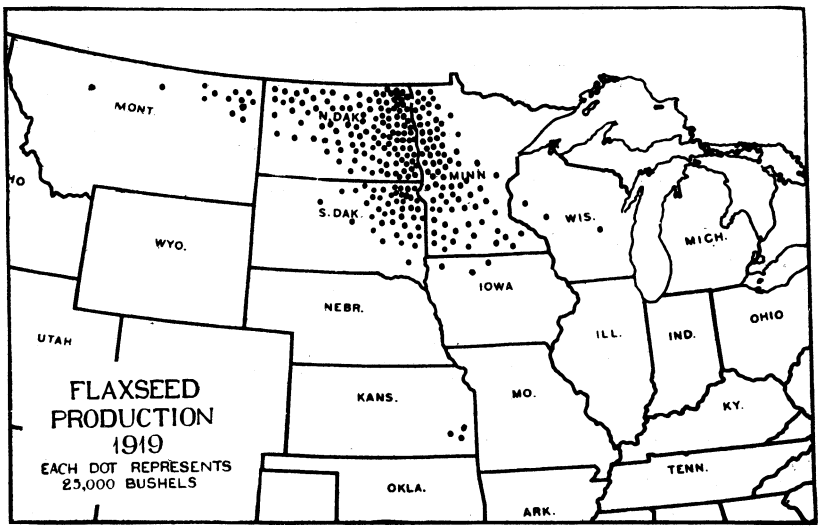

FIG. 2.—Distribution of flaxseed production in 1919, according to the census of 1920. The four States of North Dakota, Minnesota, South Dakota, and Montana produce approximately 95 per cent of all the flaxseed grown in the United States.

this area the crop depends largely upon the summer rainfall and yields well or poorly according to the amount.

Under these drier conditions flax with short coarse straw and nonuniform fiber is produced. As the crop is of little value for fiber, only the highest yielding seed-flax varieties should be grown. In the principal flaxseed-producing area, where the annual rainfall is 20 or 30 inches, seed flax produces a fair quality of fiber suitable for those industries which heretofore have used imported flax tow and waste. Where the rainfall is more abundant it is possible in some localities to grow flax producing excellent fiber for spinning. The growing of flax for fiber is treated in Farmers' Bulletin No. 669, "Fiber Flax," and the use of the straw of seed flax is discussed in Department Bulletin No. 322, "Utilization of American Flax Straw in the Paper and Fiber-Board Industry." Copies of these bulletins may be obtained upon application to the United States Department of Agriculture, Washington, D. C.

USES OF FLAXSEED

Seed flax is a cash crop, very little of it being consumed on the farms where grown. The two products of flaxseed are linseed oil and linseed meal. Linseed oil is used in the manufacture of paints and varnishes, in linoleum, oilcloth, printer's ink, patent leather, imitation leather, and a few other products. The flaxseed is ground, heated, and pressed to extract the oil. The residue left after the oil is extracted is known as linseed cake or, if ground, as linseed meal. It is a valuable feed for livestock, especially for dairy cattle and young growing animals.

Flaxseed yields from 30 to 40 per cent of its weight in oil, or, in commercial crushing, about 2½ gallons (7½ pounds per gallon) to the bushel (56 pounds) of seed.

FLAXSEED MARKETS

Minneapolis and Duluth, Minn., are the two principal markets for domestic flaxseed. Most of the flaxseed marketed at Duluth is reshipped by way of the Great Lakes to Chicago, Toledo, Buffalo, New York, and other cities where linseed-oil mills are located. The eastern mills also crush large quantities of flaxseed which is imported, chiefly from Argentina.

Several large linseed mills located in Minneapolis consume the bulk of the flaxseed marketed there. Other linseed mills at Sioux City, Iowa, Red Wing, Minn., and Fredonia, Kans., consume the flaxseed produced in their localities. A small mill at Portland, Oreg., operates largely on flaxseed imported from the Orient.

VARIETIES OF SEED FLAX

Four rather distinct groups of flax are grown commercially in the United States: (1) Textile-fiber flax, (2) short-fiber flax, (3) European seed flax, and (4) Argentine seed flax.

The textile-fiber flaxes are not grown for seed, although the seed is a by-product used for crushing when they are grown for fiber. This is the only group producing fiber suitable for spinning.

In the short-fiber group are several varieties that have been developed for resistance to flax wilt. They have been derived from the fiber-flax type and have more slender stems than the so-called Russian or European seed flaxes. They have fewer basal branches, a more compact panicle (head), and generally are somewhat earlier than the seed flaxes. The bolls and seeds are smaller than those of the seed flax.

The best known variety of this group is N. D. R. No. 114, distributed by the North Dakota Agricultural Experiment Station. Recently the Minnesota Agricultural Experiment Station has developed two varieties of this type which are highly resistant to wilt. These have been named Chippewa (Minnesota No. 181) and Winona (Minnesota No. 182). Seed of both varieties is being increased and distributed.

The European flaxes have stouter stems, more basal branches, larger and more uneven panicles, and larger bolls and seeds than the

short-fiber type. To this group belong the several strains of the so-called Russian flax, North Dakota No. 155. Two of the best of these are Damont (C. I.[1] No. 3) and Reserve (C. I. No. 19). To this group belong also N. D. R. Nos. 52 and 73, distributed by the North Dakota Agricultural Experiment Station. These varieties are grown principally on the newer lands in western North Dakota and Montana, where the wilt disease is not yet a serious factor in seed-flax production. These varieties as grown commercially generally are not very wilt resistant. Recently the development of wilt-resistant varieties of this group has been begun.

The Argentine flax of commerce is not well adapted to the flax-producing area of the United States. The plants are nonuniform and generally coarser than the seed flaxes. The stems, flowers, bolls, and seeds are larger than in the European seed types. There generally are basal branches which do not grow as tall as the main stem. The plants are late in maturing. If the plants are not ripe by the first of September, they often continue blossoming and fail to mature well. The bolls are large and retain the seeds well. The seeds also are large and when mature yield a high percentage of oil. If Argentine flax is grown, it should be seeded early so as to insure ripening.

Argentine flax is more or less resistant to flax wilt, and the plants are practically immune from flax rust. Because of its disease-resistant qualities and its large seeds Argentine flax is a promising type for the plant breeder to work with in developing new varieties. An early uniform variety should be a valuable asset to the flax-producing area of the United States.

VALUE OF GOOD SEED

There is a difference in the yield of varieties of flax under varying conditions. Where flax has been grown frequently and the wilt disease is present, it is necessary to use a wilt-resistant variety, such as N. D. R. No. 114 or one of the newer varieties, Winona or Chippewa, recently introduced by the Minnesota Agricultural Experiment Station. Such varieties yield well on wilt-infested soil, where ordinary flax would fail entirely. The United States Department of Agriculture and the North Dakota Agricultural Experiment Station each has developed new wilt-resistant varieties which are being tested and should soon be available for commercial growing.

On new lands in the flax-producing area, and especially in the northern Great Plains, varieties of the European seed flax, such as Damont, Reserve, N. D. R. No. 52, and some local strains are likely to produce maximum yields. These larger seeded varieties appear to have greater capacity to produce large yields under favorable conditions than the smaller seeded wilt-resistant varieties.

Where new seed must be obtained, it often is best to buy it in the locality from some one who is known to have a high-yielding strain free from weeds and disease. If such seed is not available, the State agricultural experiment station or the Bureau of Plant In-

[1] Accession number given by the Office of Cereal Investigations of the Bureau of Plant Industry.

dustry of the United States Department of Agriculture usually can advise where desirable seed can be purchased.

When an improved variety of flax has been obtained, it should be kept pure and free from weeds. A portion of the field that is free from disease should be chosen, and all weeds the seeds of which can not readily be separated by the fanning mill should be pulled by hand and destroyed. In this way seed flax is obtained that (1) is adapted to the locality, (2) is free from admixture with weed seed that will infest the field and reduce the yield, and (3) is relatively free from disease. It is practically impossible, however, to avoid introducing flax wilt where flax is grown on the farm continuously. When it is known that wilt is present in the soil, it is best to get seed of a wilt-resistant variety.

DISEASES OF FLAX

The principal diseases of seed flax are wilt, rust, heat canker, and pasmo.

WILT

Wilt is a fungous disease that attacks flax plants at any stage of growth, causing them to wilt and die. It grows both upon the live

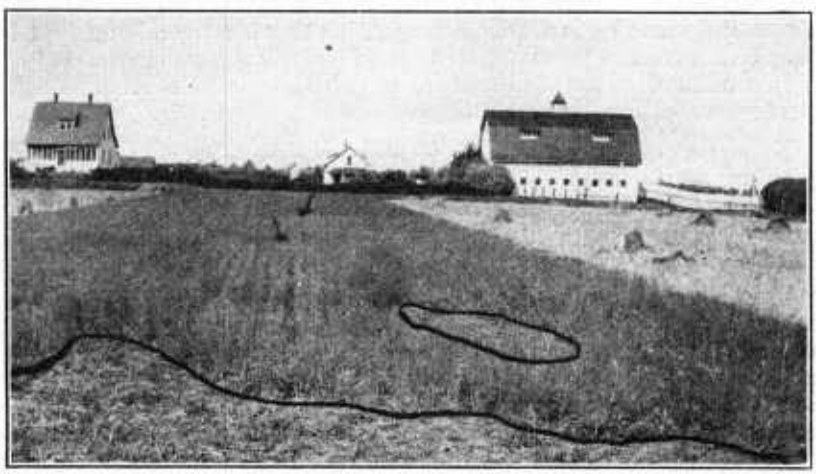

FIG. 3.—A fourth-acre plat continuously cropped to flax, showing the first appearance of flax wilt in spots. The flax is grown under irrigation on the Belle Fourche Experiment Farm, Newell, S. Dak.

plant and upon the dead flax roots and stems in the soil. When once introduced, therefore, it increases in the soil for an indefinite period. Authentic cases are known where a crop of flax was grown without noticeable loss from wilt, but when flax was sown on the same land five years later it was entirely destroyed by wilt. The fungus, no doubt, was introduced into the soil in seeding the first crop and increased during the five-year period until it was widely distributed through the soil. Figure 3 shows the effect of wilt on a plat of flax in the fifth year of continuous cropping. In many cases such spots of wilt appear in the second or third crop.

In order to avoid infection of new lands with the wilt, only mature well-cleaned seed should be sown. Care should be taken in harvesting and threshing to save the seed in a dry condition. The fungus grows rapidly on wet straw, seed bolls, and seed, and therefore only dry, bright flax should be saved for seed. Treatment with formaldehyde will kill the fungous spores on the surface of the seed and may help prevent the introduction of wilt to new land. Although it is very desirable to prevent the introduction of wilt on new land as long as possible, the most practicable method of control is to grow a wilt-resistant variety.

RUST

In some seasons rust does considerable damage to seed flax in the Red River Valley of North Dakota and in other areas where considerable flax is grown. The disease appears as bright orange pustules on the leaves and green stems early in the season. Later in the season the spots turn darker because of the appearance of the brownish spores which live over winter on the straw. As new infection comes from the old straw and stubble of the previous year a rotation which avoids putting flax on the same land two years in succession should help to control the disease. Argentine flax appears to be nearly immune from rust. The most promising method of control, therefore, appears to be the breeding of varieties resistant to both wilt and rust.

HEAT CANKER

Heat canker is caused by high temperatures at the surface of the soil when the plants are young. It often occurs in plants from 2 to 6 inches high. The stems are girdled and the plants break over. Some of these may continue to grow for a time, but ultimately they break off in the wind. The best control measure appears to be early seeding, which enables the plants to become large enough to shade the ground somewhat before the hot weather of late June and early July occurs.

PASMO

Pasmo, a new disease of flax recently described by Brentzel, appeared in many fields in North Dakota in 1922 and 1923. It has also been found in a few localities in Michigan and Minnesota, and the writer found it at Newell, S. Dak., in September, 1923. Bands of yellowish to brown mottling appear on the stems, leaves, and bolls. Irregular bands of green are left on the stem between the mottled areas. It is not yet known how much damage the pasmo causes. Fair yields of seed are obtained when the disease appears quite prevalent. It probably does more damage to fiber flax than to seed flax. Some varieties appear to be more resistant to the disease than others. Pasmo is known to be carried on the seeds, and the introduction of infected seed into new territory should be avoided so far as possible.

ROTATIONS FOR FLAX

Until recent years the bulk of the flax crop was raised on breaking. Because of the high value of the seed per bushel compared

with that of other grain, it makes an excellent crop for the farmer who must haul his grain a long distance to market. Flax seems to be well adapted to growing on prairie sod while it is rotting. It has the further advantage of being a quick-growing crop, requiring generally from 90 to 110 days from seeding to ripening. It can be sown as late as the first week of June with fair assurance of ripening, although early seeding generally is to be recommended.

Flax grown in rotation on old land should follow a crop which will free the land of weeds. A rotation which includes a legume crop, such as field peas, soybeans, sweet clover, or red clover, followed by corn which is given clean cultivation and finally by flax is generally satisfactory. Such a rotation should provide a fertile soil, clean land, and a firm seed bed. Both experiments and experience indicate that flax does well after corn or after a legume crop. It may follow either of these crops in the rotation, the choice depending upon the needs of the farm.

Flax following potatoes often is choked out by weeds, and it generally is better to follow potatoes with a more aggressive crop. The loose soils of potato fields also are not generally desirable for flax.

Experiments carried on by the Minnesota Agricultural Experiment Station[2] in which flax in 1923 followed several crops which had been grown for two years in succession (1921 and 1922) on the same plats gave interesting results. Arny says:

> The results from this work indicate that flax following corn produced the best crop. Flax following red clover, sweet clover, soybeans, and field peas was nearly as good as that following corn. Flax following wheat, oats, barley, rye, buckwheat, and flax was second rate as compared with that following corn, and flax following millet and sorghum was practically a failure. Flax following timothy was third rate. More disease was present in the flax following timothy than in the flax following the other crops mentioned.
>
> Much more extensive work needs to be done in order to learn the best place for flax in the rotation on the different soil types under the varying rainfall in Minnesota. With this information available to the growers, the adoption of flax as a regular cash crop on the farms in the State will be facilitated.

In semihumid areas where alfalfa, clover, or grass is included in the rotation flax often can be used as the nurse crop. It is a comparatively shallow feeder and does not produce dense shade and therefore makes a better nurse crop than the cereal crops which produce a ranker growth.

FLAX UNDER IRRIGATION

Flax is grown under irrigation only to a limited extent, though experiments indicate that it responds well to irrigation. On the Huntley (Mont.) Experiment Farm flax has been grown in a six-year rotation consisting of alfalfa three years, followed by corn, flax, and sugar beets. The third-year alfalfa and the corn are "hogged off," thus adding the fertility from two crops to the land. Ten years' results have now been obtained. The average yield of flax in this rotation in the 10-year period has been 24.5 bushels per acre, the highest yield being 31.8 bushels, obtained in 1918. The

[2] Arny, A. C. Growing flax as a regular farm crop. Oil, Paint and Drug Reporter, vol. 104, no. 20, p. 49, Oct. 30, 1923.

yields of beets following the flax have been high (average 14.1 tons per acre), indicating that the flax has no injurious effect on the following crop.

At the Belle Fourche Experiment Farm, Newell, S. Dak., a similar rotation is used, except that oats instead of beets follow the flax. In this rotation the average yield in the 11 years from 1912 to 1922, inclusive, has been 16.7 bushels per acre, and the highest was 24 bushels. These rotations are very favorable for flax, of course, and such high yields can not be expected under less favorable conditions. On continuously cropped plats flax has averaged 8.4 bushels per acre at Huntley and at Newell.

At Aberdeen, Idaho, flax under irrigation has yielded an average of 22.7 bushels per acre over a period of six years.

At Brooks, Alberta, Canada, the water requirement of flax grown in field plats under irrigation in 1920 and 1921 was determined. The use of 0.85 acre-feet of water applied in 4-inch irrigations was required to produce a 10-bushel acre yield of flax; 1.1 acre-feet produced 15 bushels, 1.25 acre-feet produced 18.5 bushels, 1.3 acre-feet produced 20 bushels, and a maximum yield of 21.5 bushels per acre required 1.34 acre-feet of water.

It required 5½ inches more water to produce a yield of 18.5 bushels per acre when applied in 6-inch than when applied in 4-inch irrigations. Flax, being a comparatively shallow rooted crop, is best watered with the lighter irrigations.[3]

Under irrigation flax is sown at a somewhat heavier rate, usually 45 pounds per acre. It is desirable to seed early, so that the crop may have a long growing season. When the crop begins to ripen it is desirable to withhold irrigation in order to hasten ripening. If the soil is kept wet, blooming may continue indefinitely.

FLAX AND WHEAT AS A MIXED CROP

Flax in mixture with spring wheat is grown extensively in Goodhue County, Minn., and the surrounding district. Because of the favorable results obtained in this county the mixed crop was grown to some extent throughout much of the flax-producing area in 1923. The chief advantages of the mixed crop over flax grown alone appear to be (1) the greater ease of handling in harvesting and threshing, (2) the better control of weeds, and (3) a possible greater total return per acre.

The mixed crop handles well in harvesting. The longer bundles, tapering toward the top, make it possible to build better shocks and stacks than are possible with flax alone. A photograph of a shock of mixed flax and wheat is shown in Figure 4.

Weeds are controlled to a greater extent in the mixed crop than in flax alone. The partial shading effect and taller growth of the wheat plants hold many weeds in check. Numerous experiments carried on in Minnesota, North Dakota, and Wisconsin indicate that the mixed crop generally contains fewer weeds than flax grown alone. Certain weeds, especially wild oats, appear to grow as vigorously in the mixed crop as they do in either wheat or flax alone.

[3] Snelson, W. H. Irrigation practice and water requirements for crops in Alberta. Canada Dept. Int., Reclam. Serv. Irrig. Ser. Bul. 6, 59 p., illus. 1922.

An average increase in yield of from 5 to 10 per cent may be expected from the mixed crop, according to experiments carried on at University Farm, St. Paul, Minn.; that is, 2 acres of the mixed crop should produce on the average from 5 to 10 per cent more grain than 1 acre of wheat and 1 acre of flax.

The mixed crop is sown at the usual date for seeding spring wheat, or a little later if there is danger of severe freezing weather after the flax emerges. The usual rate of seeding in Minnesota is 28 pounds of flax with 30 or 45 pounds of wheat per acre. Probably less seed should be sown where the rainfall is less, as in the Dakotas. In experiments at Dickinson and at Mandan, N. Dak., in 1923, mixtures ranging from 15 pounds of flax with 20 pounds of wheat to 25 pounds of flax with 30 pounds of wheat per

FIG. 4.—A typical shock of mixed flax and wheat, showing the well-shaped bundles made by the binder. Such bundles handle easily in shocking and stacking

acre produced satisfactory yields. A seeding rate of 20 pounds of flax with 20 or 25 pounds of Marquis wheat per acre should be enough in this drier area. The two kinds of seed are mixed and sown with a drill from 1 to 1½ inches deep. Marquis spring wheat generally is used, as it ripens at about the same time as flax. Furthermore, it does not shade the flax excessively, as ranker varieties do. A view of a field of mixed flax and wheat is shown in Figure 5.

DISADVANTAGES OF THE MIXED CROP

The mixed crop is not to be recommended where there is a ready sale for pure flax straw. Straw from the mixed crop has no value for manufacturing purposes, but probably is fully as good as flax straw for feeding to stock or for bedding animals. These facts should be considered in determining whether the mixed crop or flax alone is to be grown.

Another disadvantage, especially where a large acreage is grown. is that the mixed grain must be separated before it is marketed. The separation is made easily with an ordinary fanning mill by using the proper sieves. A steel wire sieve with meshes 4 by 16 to the inch is satisfactory.

GROWING SEED FLAX

PREPARING THE SEED BED

Flax requires a firm seed bed. Poor stands often are due to seeding too deep in loose soil. Sod broken in the fall or spring should be packed by heavy rolling or by disking, harrowing, and rolling and the surface made level before seeding. Spring breaking should be prepared as soon as possible after breaking, in order that the seed may be sown before the turned sod becomes dry. Where tractor

FIG. 5.—A close view of mixed flax and wheat in a field near Red Wing, Minn. Such a mixture usually will yield about half flax and half wheat

outfits are used, plowing, disking, packing, and seeding often are done in one operation.

A firm seed bed is as essential when flax is grown in rotation with other crops on old land, as it is on new breaking. For this reason corn ground usually is disked instead of plowed in preparation for flax. If spring plowing is necessary, the land should be made firm by rolling or disking, with the disks set nearly straight, and harrowing.

Pasture and meadow lands usually should be broken in the late summer or fall in preparation for flax. The rough sod will catch and hold the snow, frequent freezing and thawing will mellow the sod, and the land can be put in shape for earlier seeding in the spring.

Whether fall or spring plowing of stubble land is best for flax depends upon the conditions under which the crop is to be grown. In the humid area fall plowing and early-spring seeding generally

are considered best. Where a large acreage is sown, however, it often is impracticable to plow all the land in the fall. In the drier areas the winter cover of stubble catches and holds the snow, adding moisture to the soil. Under such conditions spring plowing may give the best results.

It is very necessary to prepare a firm even seed bed, so that the seed may be sown at a uniform depth. All harrowing should be done before seeding. Harrowing after the drill covers many seeds too deep and prevents the young plants from reaching the surface.

METHOD OF SEEDING

Flax should be sown about 1 inch deep in a firm seed bed. A press drill is desirable for seeding flax, as it firms the soil around the seeds, thus insuring even germination. The ordinary grain drill, however, generally is used. When it is necessary to sow on loose soil, it sometimes is desirable to release the pressure springs on the drill and depend upon the weight of the disks to place the seed at the proper depth.

In seeding flax and wheat the two kinds of seed are mixed in the desired proportions at the granary and sown together. The mixed seed should be sown 1 or 1½ inches deep.

CONTROL OF WEEDS

Because flax is a poor weed fighter it should be grown on the cleanest land available. Newly turned sod of prairie, pasture, and meadow lands and clean corn stubble are best for flax.

Where old ground is used every effort should be made to rid the land of weeds before seeding. It often is an advantage to disk fall-plowed land early in the spring to start the growth of weeds. After 10 days or two weeks this land may be disked again, or harrowed well, just before seeding to flax, in order to kill the sprouting weeds. The object is to destroy weeds and weed seeds and still sow the flax as early as possible. Where late warm-weather weeds, such as green and yellow foxtail (pigeon grass), are troublesome the flax should be sown early, so that it may become well established before these weeds begin growth. Early-sown flax usually will ripen before green foxtail ripens, and the immature weed seeds may be separated from the flax in recleaning by using a strong air blast.

Where Russian thistles are troublesome, as in the drier parts of the flax-producing area, it often is an advantage to disk corn stubble some two weeks before seeding and again just before seeding. The first cultivation starts the germination of innumerable weed seeds, and the seedlings are killed by the second disking. Indeed, it may be necessary only to harrow for the second cultivation in order to kill sprouting weeds and put the soil in good tilth. Russian thistles are at their best in dry seasons, and as they draw heavily on the soil moisture flax can not do well where these weeds are numerous.

TIME OF SEEDING

It is the custom to seed flax late on breaking or as a catch crop on old land. This practice has led many growers to believe that

flax should not be sown until about the first of June. Experiments show that early-sown seed generally produces the highest yields. Early seeding allows the plants to mature seed before the hot dry weather of midsummer occurs. Contrary to common belief young flax is not easily injured by frost. It will endure a temperature of 25° F. when the plants are just coming up and a still lower temperature after the plants are 3 or 4 inches high. On the other hand, late-sown flax is easily injured by fall frost occurring before the crop is ripe.

Experiments conducted on the northern Great Plains area in the past 10 years indicate that flax sown in the latter part of April or the first part of May usually produces the highest yield. For best development flax requires cool weather at the time of blossoming

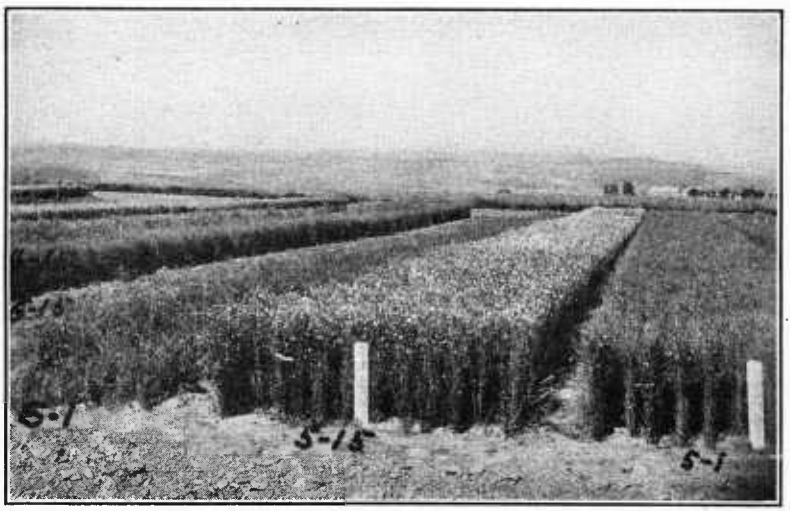

FIG. 6.—Plats of flax sown at intervals of 15 days from April 15 to June 15, 1922, at Mandan, N. Dak. The plat sown on May 15 was in full bloom when photographed on July 7, 53 days after seeding

and ample moisture until ripening begins. Such conditions are most likely to be met if the seed is sown early.

Flax may be sown during the first week of June, however, with fair assurance that it will ripen before frost. Later seeding than this often results in low yields, even though the crop escapes frost. Plats of flax sown at intervals of 15 days from April 15 to June 15 at Mandan, N. Dak., in 1922, are shown in Figure 6.

As mentioned under the heading "Control of weeds," it often is an advantage on weedy land, especially where Russian thistles are abundant, to delay seeding and cultivate the land with disk and harrow in order to germinate seeds and destroy the weeds before seeding to flax. On the other hand, where green and yellow foxtail (pigeon grass) are bad weeds, flax should be sown early, so that it may become well established before these warm-weather weeds get started.

RATE OF SEEDING

In western Minnesota, eastern South Dakota, and eastern North Dakota the usual rate of seeding flax is a half bushel (28 pounds)

per acre. Farther east, where the rainfall is greater, it is considered an advantage to seed from 30 to 40 pounds per acre. The heavier rate of seeding may help to control weeds. In the northern Great Plains area under dry-farming conditions 20 or 25 pounds of seed per acre are sufficient.

Under irrigation flax usually is sown at the rate of 40 or 45 pounds per acre. It is not known whether a lower rate of seeding would yield as good returns.

HARVESTING THE CROP

The plants should be fully ripe when cut, unless unusual conditions make this impracticable. Fully ripe flax will dry quickly in the shock or bunch. If sown late or if the season is wet and cool, it may continue to bloom until frost. Under such conditions it will be

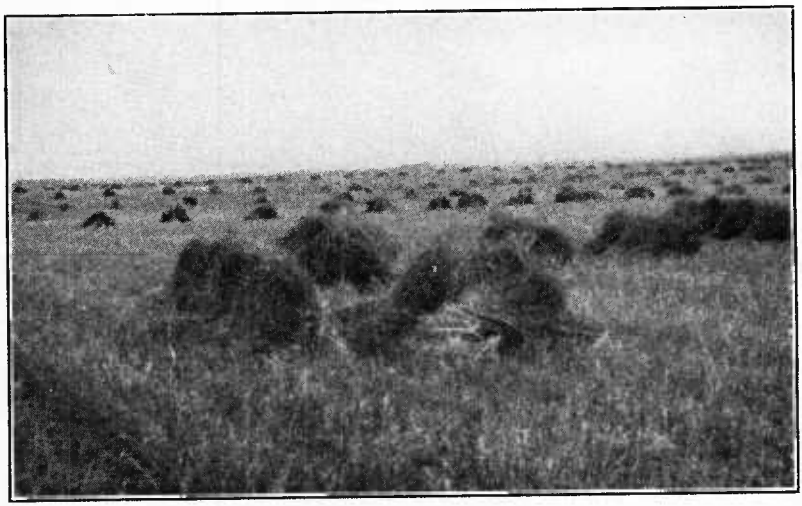

FIG. 7.—Seed flax harvested and bound with a grain binder and put up in narrow shocks to dry

necessary to cut the crop when a large proportion of the bolls are ripe, even though the stems are still green.

Flax generally is cut and bound with a grain binder. By proper adjustment, bundles of fair size and shape can be made. When bound flax is shocked the bolls are kept from the damp ground and the seed is not damaged.

In the drier area flax sometimes is cut with a header. It then may be stacked in long, low ricks, or an automatic dropper may be attached to the header elevator and the flax dropped in small bunches on the ground. Reapers also are used for cutting flax. The reaper and the header save the expense of twine and the labor of shocking, and the small loose bunches dry out rapidly in clear weather. In case of rain, however, the bunches should be turned to dry or much seed will be damaged.

If the flax is bound it should be put in small shocks made so as to allow ventilation through the center or in long shocks of only two bundles in width (fig. 7).

Flax should not be stacked until it is thoroughly dry. The stacks may be protected from rain by a covering of hay or a tarpaulin. This is desirable especially if the flax is intended for seed.

Flax most often is threshed from the shock or bunch, and this is the most economical method. It is desirable to thresh as soon as the flax is thoroughly dry, so as to avoid the risk of loss from rain. Flax is damaged both for oil and for seed purposes if allowed to remain wet in the bunch or shock for a few days.

For best results in threshing, flax should be thoroughly dry. It should be fed into the machine evenly and not too fast. The bolls, leaves, and stems break up and overload the sieves, so that a good job of cleaning can not be done unless judgment is used in feeding.

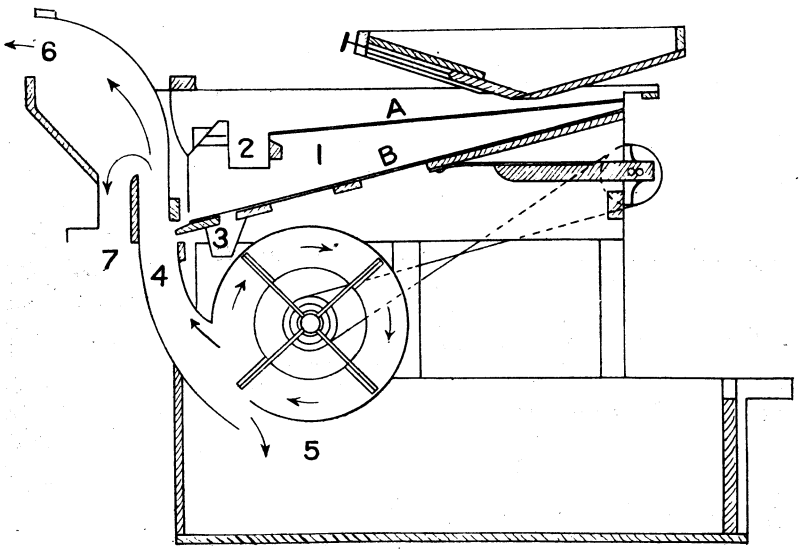

FIG. 8.—A good type of grain-cleaning mill which will reclean flax for seed and separate the mixed grain, flax, and wheat. 1. Shoe, carrying upper (*A*) and lower (*B*) screens. The shoe is given an end shake by means of an eccentric bearing operated by the crank shaft. 2. Spout which carries off coarse material separated by the upper sieve (*A*). An upper sieve with meshes 4 by 16 per inch will separate wheat from flax. 3. Screening spout which receives small weed seeds separated by the lower sieve. 4. An air current driven up through the falling grain carries off chaff and dust through the hood (6). Light seeds fall through the open space (7). 5. Grain box which receives clean grain. Cone pulleys on the fan and drive shafts make it possible to drive the fan at any speed necessary to remove light seeds and trash

Where flax is intended for seed, the machine should be cleaned thoroughly and run empty for a few minutes, in order to remove any weed seeds or diseased flax seeds that may have lodged in the machine.

RECLEANING THE SEED

When flaxseed contains a high percentage of dockage, especially if the dockage is grain that is valuable for feeding, it usually will pay to reclean the flax before marketing. Hundreds of cars of flax are shipped to market that contain from 10 to 40 per cent dockage. It probably would pay to reclean such flaxseed, grind the screenings, and feed them on the farm. Cracked flax, grain, and

some weed seeds are valuable feeding stuffs, and yet the grower receives little or no pay for them as dockage. Such screenings should be finely ground, to avoid scattering weed seeds about the farm.

Flaxseed should be thoroughly cleaned with a good fanning mill before sowing. A good type of farm fanning mill is shown in Figure 8. This type of mill cleans the seed by two principles, first, separation by sieves according to size, and, second, separation according to weight. The seed falls through a strong air blast which blows out the lighter seeds. A steel-wire sieve with meshes 4 by 16 per inch will separate grain and the larger weed seeds from flax. A metal sieve with round holes one-fourteenth of an inch in diameter will separate small weed seeds. The air blast should be regulated so as to blow out all immature, scaly, and cracked flax seeds and trash.

STORING THE SEED

Flax intended for seeding should be well recleaned before storing, and only dry, sound, plump seed should be saved. This will reduce the development of wilt and other diseases which may be carried as spores on the broken stems, chaff, and immature seeds. Flax should be dry and stored only in a dry place.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

October 20, 1924

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